

METHOD AND APPARATUS FOR GENERATING HAPTIC FEEDBACK FROM PLASMA ACTUATION

RELATED APPLICATIONS

[0001] This application is related to the following co-pending applications, each assigned to the Assignee of the present invention.

[0002] a. Application Ser. No. 11/823,192, filed Jun. 26, 2007, Attorney Docket No. IMM255 (1057.P0002US), entitled "Method and Apparatus for Multi-touch Tactile Touch Panel Actuator Mechanisms";

[0003] b. Application Ser. No. 11/823,258, filed Jun. 26, 2007, Attorney Docket No. IMM272 (1057.P0003US), entitled "Method and Apparatus for Multi-touch Haptic Touch Panel Actuator Mechanisms"; and

[0004] c. Application Ser. No. 11/943,862, filed Nov. 21, 2007, Attorney Docket No. IMM290 (1057.P0014US), entitled "Method and Apparatus for Providing a Fixed Relief Touch Screen with Locating Features Using Deformable Haptic Surfaces."

[0005] d. Application Ser. No. 12/061,463, filed Apr. 2, 2008, Attorney Docket No. IMM280 (1057.P0006US), entitled "Method and Apparatus for Providing Multi-Point Feedback Texture Systems."

FIELD

[0006] The exemplary embodiment(s) of the present invention relates to a field of electronic interface devices. More specifically, the exemplary embodiment(s) of the present invention relates to actuator materials for generating haptic feedback.

BACKGROUND

[0007] As computer-based systems, appliances, automated teller machines, point of sale terminals and the like have become more prevalent in recent years, the ease of use of the human-machine interface has become increasingly important. A conventional touch-sensitive panel usually has a smooth flat surface and uses sensors such as capacitive sensors and/or pressure sensors to sense locations being touched by a finger(s) and/or an object(s). For example, a user presses a region of a touch screen commonly with a fingertip to emulate a button press and/or moves his or her finger on the panel according to the graphics displayed behind the panel on the display device. To generate haptic sensation in response to a touch on a touch screen, typical mechanical actuators or carries, for instance, may be used to emulate a button.

[0008] A problem associated with the conventional approach for generating a haptic feedback is relying on global motion of a mechanical carrier attached to the touch screen to produce haptic or tactile feedback. The conventional mechanical actuator or carrier, which is capable of generating global motion, is usually bulky, heavy, and difficult to assemble due to many mechanical parts.

SUMMARY

[0009] A method and device for generating haptic feedback over a touch surface using plasma actuation are disclosed. A haptic device includes a touch surface, plasma, and a substrate. In one embodiment, the touch surface, which can be made of flexible and/or deformable materials, is capable of sensing one or more events. The substrate is situated adjacent

to the touch surface with a separation gap, which physically separates the substrate from the touch surface. The substrate provides haptic feedback in response to the event(s). The plasma is capable of accumulating at one or more pockets located in the separation gap, and configured to facilitate the haptic feedback via energy transfer.

[0010] Additional features and benefits of the exemplary embodiment(s) of the present invention will become apparent from the detailed description, figures and claims set forth below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The exemplary embodiment(s) of the present invention will be understood more fully from the detailed description given below and from the accompanying drawings of various embodiments of the invention, which, however, should not be taken to limit the invention to the specific embodiments, but are for explanation and understanding only.

[0012] FIGS. 1(a-e) illustrate haptic devices using haptic substrates and flexible surfaces in accordance with one embodiment of the present invention;

[0013] FIGS. 2(a-d) illustrate cross section views of haptic devices capable of generating haptic feedback using plasma actuator in accordance with one embodiment of the present invention;

[0014] FIGS. 3(a-b) illustrate top views of haptic devices capable of generating haptic feedback using plasma actuator in accordance with one embodiment of the present invention;

[0015] FIGS. 4(a-d) illustrate examples of haptic cells in a haptic device employing piezoelectric materials and Micro-Electro-Mechanical Systems ("MEMS") elements in accordance with one embodiment of the present invention;

[0016] FIG. 5(a-b) illustrates a side view of a haptic device having an array of haptic cells with thermal fluid pockets in accordance with one embodiment of the present invention;

[0017] FIG. 6(a-b) illustrates a haptic cell employing MEMS pumps to generate haptic effects in accordance with one embodiment of the present invention;

[0018] FIG. 7 illustrates a side view diagram for a haptic device having an array of haptic cells using variable porosity membrane in accordance with one embodiment of the present invention;

[0019] FIG. 8 is a side view of a haptic device having an array of haptic cells using various resonant devices in accordance with one embodiment of the present invention; and

[0020] FIG. 9 is a flowchart illustrating a process of generating haptic feedback from plasma actuation in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION

[0021] Exemplary embodiments of the present invention are described herein in the context of a method, system and apparatus for providing haptic feedback on a touch surface using plasma actuator.

[0022] Those of ordinary skill in the art will realize that the following detailed description of the exemplary embodiment(s) is illustrative only and is not intended to be in any way limiting. Other embodiments will readily suggest themselves to such skilled persons having the benefit of this disclosure. Reference will now be made in detail to implementations of the exemplary embodiment(s) as illustrated in the accompanying drawings. The same reference indicators will be used